ABSTRACT

A SiGe monocrystalline etch-stop material system on a monocrystalline silicon substrate. The etch-stop material system can vary in exact composition, but is a doped or undoped $Si_{1-x}Ge_x$ alloy with x generally between 0.2 and 0.5. Across its thickness, the etch-stop material itself is uniform in composition. The etch stop is used for micromachining by aqueous anisotropic etchants of silicon such as potassium hydroxide, sodium hydroxide, lithium hydroxide, ethylenediamine/ pyrocatechol/ pyrazine (EDP), TMAH, and hydrazine. These solutions generally etch any silicon containing less than $7x10^{19}$ cm^{-3} of boron or undoped $Si_{1-x}Ge_x$ alloys with x less than approximately 18. Alloying silicon with moderate concentrations of germanium leads to excellent etch selectivities, i.e., differences in etch rate versus pure undoped silicon. This is attributed to the change in energy band structure by the addition of germanium. Furthermore, the nondegenerate doping in the $Si_{1-x}Ge_x$ alloy should not affect the etch-stop behavior. The etch-stop of the invention includes the use of a graded-composition buffer between the silicon substrate and the SiGe etch-stop material. Nominally, the buffer has a linearly-changing composition with respect to thickness, from pure silicon at the substrate/ buffer interface to a composition of germanium, and dopant if also present, at the buffer/ etch-stop interface which can still be etched at an appreciable rate. Here, there is a strategic jump in germanium and concentration from the buffer side of the interface to the etch-stop material, such that the etch-stop layer is considerably more resistant to the etchant. This process and layer structure allows for an entire range of new materials for microelectronics. The etch-stop capabilities introduce new novel processes and structures such as relaxed SiGe alloys on Si, SiO_2, and SiO_2/Si. Such materials are useful for future strained Si MOSFET devices and circuits.